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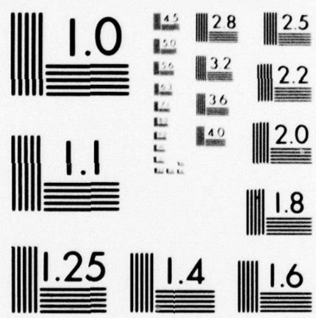
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A 20-mA Current Loop Interface for the Commodore (PET) Microprocessor

Rotor Protection of VACM-Type Current Meters

272 268

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EXPOSURE

vol.6 no.4 a newsletter for ocean technologists

A 20-mA Current Loop Interface For The Commodore (PET) Microprocessor

The Oregon State University Shipboard Data System design[1] incorporates the capability of using a programmable intelligent terminal as a system "manager". During the development of the data system, we used a Commodore PET (Personal Electronic Transactor) as such a manager.

The PET is an inexpensive microprocessor-based device containing a fairly powerful set of BASIC instructions. The user is provided with an IEEE-488 I/0 port, an 8-bit parallel I/0 port, and a memory-expansion port. There is, however, no serial I/0 capability which lends itself to serial-ASCII operations (required by the Shipboard Data System).

We have therefore developed a circuit which interfaces a serial-transmission 20-mA current loop to the 8-bit parallel I/0 port of the PET. The following description assumes a familiarity with the operation of the various electronic components in the interface. The description divides the interface into three sections: PET parallel I/0 port, the UART, and 20mA current loop. Reference should be made to the schematic diagram, Figure 1.

PET Parallel I/0 Port

The parallel I/0 port, hereafter called the port, contains eight "data" lines and two "control" lines. All these lines are under program control and can be acted upon by using BASIC instructions. Any of the eight data lines (singly or in groups) can be programmed to act as an input line or as an output line. One of the control lines (CB2) can be used as either an input or an output, while the other control line (CA1) can be used as an input only. As used in the foregoing, "input" and "output" are in reference to the PET. Actual programming of this port will not be discussed; however, Figure 2 shows a simple program in BASIC language, with comments.

[1] Exposure, Vol. 6, No. 3 (July 1978)

September 1978

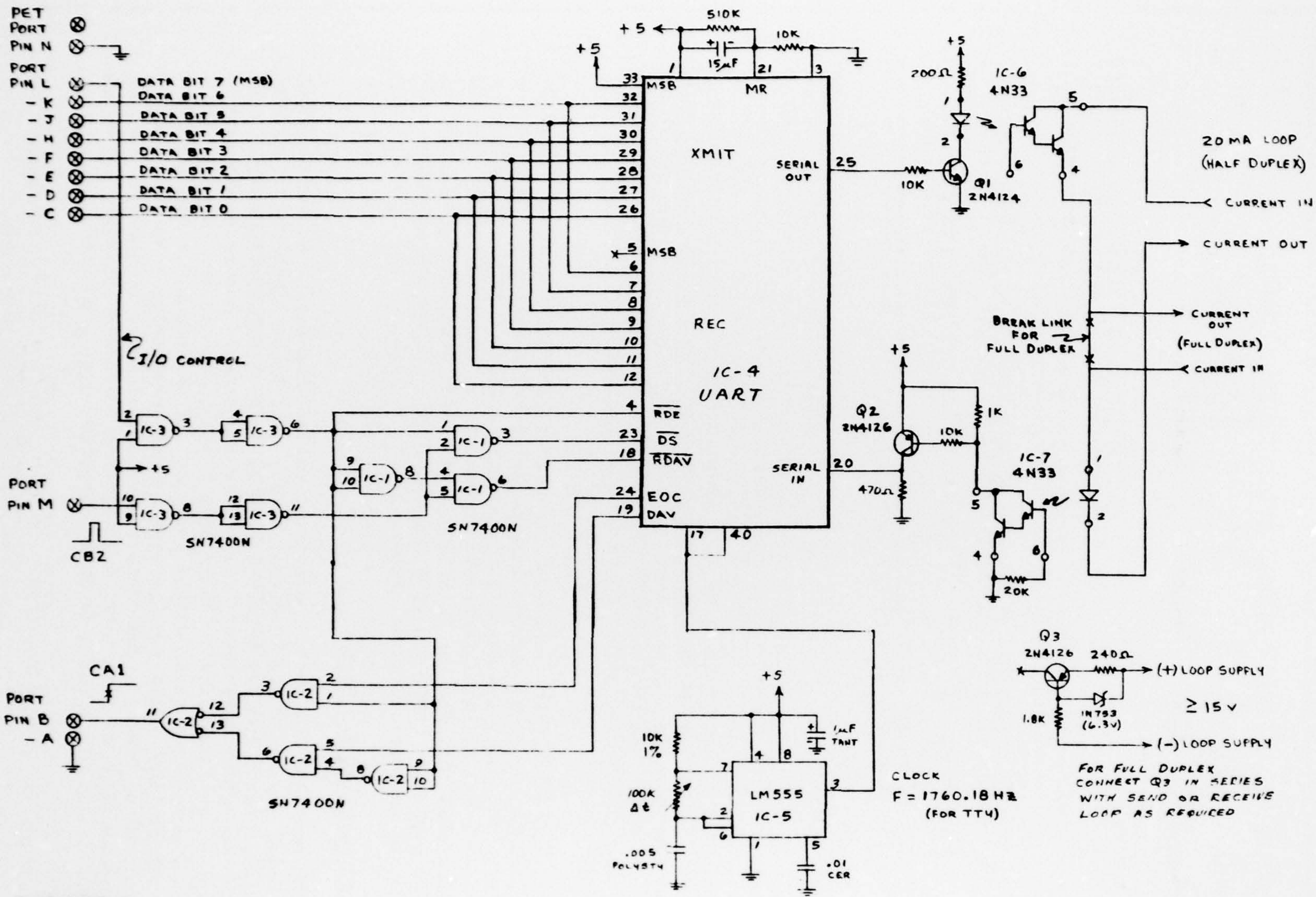
PET PORT PIN N
PORT PIN L
– K
– J
– H
– F
– E
– D
– C
DATA BIT 7 (MSB)
DATA BIT 6
DATA BIT 5
DATA BIT 4
DATA BIT 3
DATA BIT 2
DATA BIT 1
DATA BIT 0
I/O CONTROL
PORT PIN M
CB2
SN7400N
CA1
PORT PIN B
– A
IC-4 UART
XMIT
REC
SERIAL OUT
SERIAL IN
MSB
MR
RDE
DS
RDAV
EOC
DAV
510K
15μF
10K
+5
200Ω
IC-6 4N33
Q1 2N4124
20 MA LOOP (HALF DUPLEX)
CURRENT IN
CURRENT OUT
BREAK LINK FOR FULL DUPLEX
CURRENT OUT (FULL DUPLEX) CURRENT IN
Q2 2N4126
470Ω
1K
IC-7 4N33
20K
Q3 2N4126
240Ω
(+) LOOP SUPPLY
≥ 15 V
1N753 (6.3V)
1.8K
(–) LOOP SUPPLY
FOR FULL DUPLEX CONNECT Q3 IN SERIES WITH SEND OR RECEIVE LOOP AS REQUIRED
LM555 IC-5
10K 1%
100K Δt
.005 POLYSTY
1μF TANT
.01 CER
CLOCK
F = 1760.18 HZ
(FOR TTY)

FIGURE 1.

FIGURE 2. Basic Program

Assign Variables to Port Addresses

```
Line No.        Statement                              Comment

40              DR = 59457
41              DD = 59459
42              AR = 59467
43              CR = 59468
44              FR = 59469
```

Flag Test Subroutine (CA1 line)

```
50              M = PEEK (FR)
55              IF M AND 2  THEN RETURN
60              GOTO 50
```

CB2 Pulse Subroutine

```
100             POKE CR, 225
105             POKE CR, 193
110             RETURN
```

(All the above subroutines apply to the input and output programs)

Output Mode Subroutine - Set up Port as Output

```
150             POKE AR, 0
151             POKE CR, 193
152             POKE DD, 255
155             POKE DR, 141                 - send carriage return (13 + 128)
160             GOSUB 100                    - branch to subroutine at line 100
165             GOSUB 50                     - branch to subroutine at line 50
170             POKE DR, 138                 - send linefeed
175             GOSUB 100
180             GOSUB 50
185             RETURN
```

Input Mode Subroutine - Set up Port as Input

```
200             POKE DD, 128
205             POKE DR, 0
210             POKE AR, 0
215             POKE CR, 193
220             GOSUB 100
225             RETURN
```

ALL THE ABOVE COMMON TO BOTH PROGRAMS

Program to Output Characters from PET Keyboard (User Types RUN 300)

```
Line No.        Statement                         Comment

300             GOSUB 150                         - set up port as output
305             GET D$:  IF D$ = "" THEN 305      - get keyboard character
310             D = ASC (D$)                      - decimal equiv. of ASCII
315             PRINT CHR $ (D);                  - display character on PET screen
320             POKE DR, D + 128                  - load character into port
325             GOSUB 100                         - pulse CB2 (start serial transmission)
330             GOSUB 50                          - test for end-of-character (UART)
335             IF D < > 13 GOTO 305              - D not equal to 13 (13 is car. ret.)
340             POKE DR, 138                      - send linefeed (10 + 128)
345             GOSUB 100
350             GOSUB 50
355             GOTO 305                          - go back, wait for next KYBD character
360             END
```

Program to Input Characters to PET (User Types RUN 400)

```
400             GOSUB 200                         - set up port as input
405             GOSUB 50                          - test for incoming character (flag)
410             D = PEEK (DR)                     - read character at port
415             GOSUB 100                         - pulse CB2 (clear UART flag)
420             PRINT CHR$ (D);                   - display character on PET screen
425             GOTO 405                          - go back and wait for new character
430             END
```

The UART

The UART (Universal Asynchronous Receiver-Transmitter) integrated circuit has become a popular way to translate parallel information to or from a bit-serial format. UARTS are particularly useful for serial-ASCII transmissions, since most of the necessary "housekeeping" is done within the UART. This 20-mA current loop interface utilizes a CMOS unit (Intersil IM6402) to reduce supply-current requirements, but other versions of the UART can be used.

The interface schematic shows three sets of gates associated with the UART. One set of gates (IC-3) is used to buffer two of the port lines, because of the limited drive capability of the port. Since there are more pulses and flags associated with the UART than there are "control" lines available at the port, the other two sets of gates (IC-1 and IC-2) are used as steering logic.

If the port is being used to output data (from the PET), then all eight data lines of the port are programmed as output lines. The seven low-order data lines are connected to the transmit input and to the receive-register output of the UART. The most-significant-bit data line (bit 7) is used as an I/O control of the UART. Bit 7 is required to be in the high state during output, and is applied as a logic one to the receive-data-enable (RDE) pin of the UART. Since the UART receive-register output is tri-state, the receive register is in effect disconnected from the port data lines by the logic high applied to RDE.

To enter the information on the seven data lines into the UART and to start serial transmission, port control line CB2 is made to act as an output, then is pulsed high, under program control. CB2 is steered by IC-1 (I/O control is high at IC-1 pin 1) to the data strobe (DS) pin on the UART.

Since most devices which handle ASCII have a provision for ignoring the parity bit, the most-significant-bit of the UART transmit-input is wired high, causing that bit to be always transmitted as a mark (logic one). The UART is wired for 8-bit, no-parity operation.

After the UART has serially transmitted the data word just entered, the UART end-of-character flag (EOC) will be set high. This flag is steered by IC-2 (I/O control is high at IC-2 pin 1) to the port control line CA1. CA1 can be used only as an input to the PET. Therefore, CA1 is used by this interface to set a flag internal to the PET. The PET is programmed to recognize (set its flag on) the positive-going edge of CA1. The EOC flag from the UART signals the PET that the UART has finished transmitting a character (data word).

If the parallel I/O port is being used to input data (to the PET), then the most-significant-bit (bit 7) data line is programmed as an output line, and the seven low-order data lines are programmed as input lines. The bit-7 data line is required to be in the low state during input. The bit-7 line, it may be recalled, is the interface I/O control.

With the port in the input mode, a serial data-word (character) is expected at the serial-input pin of the UART. The UART receives this serial character, translates it to an 8-bit parallel word, and presents that word to the receive-data register of the UART. The seven low-order bits of the receive-data register output are connected to the UART transmit-input pins and to the seven low-order data lines of the port. However, the I/O control (port bit 7) is low in the input mode, is applied to the receive-data enable (RDE) of the UART, and causes the UART parallel output to be present at the port data lines.

After the UART has received a serial character and converted it to 8-bit parallel, the UART raises the data available (DAV) flag. DAV is steered to control line CA1 by IC-2 (pin 4 of IC-2 is high). A positive transition of control line CA1 sets a flag in the PET, signalling that a data word is ready at the port.

After the PET "reads" the word at the port, the control line CB2 will be pulsed high under program control. This CB2 pulse is now routed by the I/O control (inverted, IC-1) to the UART reset data available (RDAV) pin, clearing the DAV flag so that the flag may respond to the next (if any) incoming serial character. (Included in the program which sets up the port as an input port should be a CB2 pulse to initially clear the receive data flag.)

One more item is associated with the UART: a clock generator to supply the proper baud rate. This interface uses an LM555 in the astable mode. Using low temperature-coefficient resistors and a polystyrene capacitor for the timing elements provides stability sufficient for shipboard use. The baud rate presently in use is 110, for teletype.

20-mA Current Loop

The relative merits of the 20-mA loop will not be discussed; this description deals with the manner in which the interface is connected to the loop. We have chosen optical coupling because of the obvious isolation that it provides.

The serial input and serial output pins of the UART are characterized as (TTL) voltage-sensitive terminals.

Due to the limited drive capability of the CMOS UART used in this interface, transistor Q1 is used as a driver for the serial output opto-isolator which switches the 20 mA in the loop on and off. The "receive" opto-isolator operates into transistor Q2, which inverts and shapes the signal to drive the UART serial input terminal. Q2 was used in the original design to allow the 20-mA loop to operate at speeds of at least one kilobaud; likewise the resistor between pins 4 and 6 of the "receive" opto-isolator (IC-7) allows the Darlington phototransistor to switch faster.

The loop is normally wired for half-duplex operation, and a 20-mA current regulator (Q3) is provided. However, the 20-mA loop may also be operated full-duplex as noted on the schematic, provided that the PET is programmed to handle full-duplex (i.e., simultaneous send and receive) operation. One caution should be observed with this method of coupling to the 20mA loop: the 4N33 opto-isolators have a 30 V breakdown; therefore, the loop supply should not exceed this voltage level.

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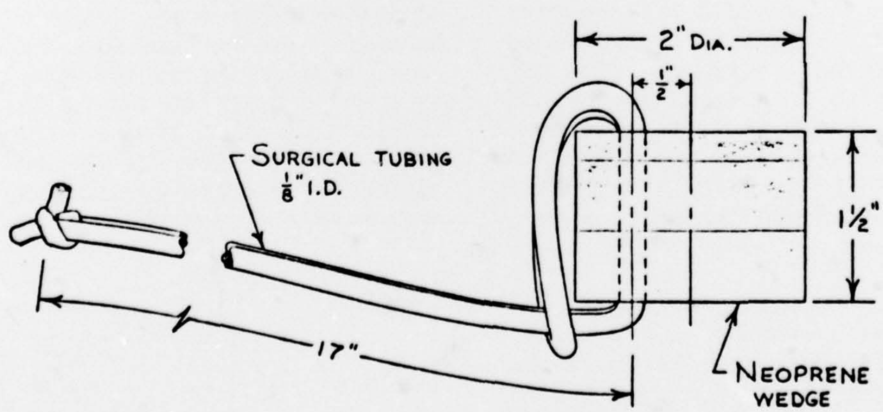
Walt Dillon came to the School of Oceanography at OSU as a scientific instrument technician in 1968, after 6 years as a development technician in automated measuring equipment for nuclear physics research at the Lawrence Radiation Laboratory, Berkeley, California. He received his basic electronics schooling in the Navy, where he spent 8 years in the radio-communications field. Dillon is presently working on the development and fabrication of electronic instrumentation systems for oceanographic research.

Rotor Protection of VACM-Type Current Meters

The standard Scripps Institution of Oceanography model 6 and model 8 current meters use Savonious rotors. The rotor bearings are sensitive to shock during transportation and launch. The standard method of rotor protection during shipping is a wedge of open-cell foam which when compressed and placed between the bottom of the rotor and its mounting frame will lift the rotor off its bearing. Occasionally, these foam wedges are inadvertently left in place after launch, resulting in lost data. However, if the wedge is not left in place until the current meter is about to be placed in the water, the unlubricated rotor bearing can be damaged by high speed rotation caused by wind gusts.

To avoid data loss and rotor bearing damage, a new type of rotor protection scheme was tried during the joint Scripps Institution of Oceanography/ Woods Hole Oceanographic Institution California Acoustic Propagation Experiment. It is a cylinder of laminated, closed-cell, SC-41 grade neoprene (Figure 1). A surgical rubber tube looped through the foam wedge is tightened around the current meter base. When the instrument descends, the foam compresses and is extracted by the rubber tube.



S.I.O. CLOSED-CELL
FOAM ROTOR-PROTECTOR

FIGURE 1.

TYPICAL COMPRESSION OF SC-41 GRADE NEOPRENE

DEPTH (FEET)	PERCENT ORIGINAL THICKNESS
0	100
30	85
50	70
100	55
150	45
200	40
300	35 (Turns negatively buoyant)

TABLE 1.

Samples of SC-41 grade foam, from different sources, were tested. All foam samples compressed about the same amount with depth, but they varied widely in texture, tear resistance, ease of bonding, and tendency to "set" once compressed. Generally, any SC-41 grade foam will make acceptable wedges if it has good lamination characteristics and moderate tear resistance. Some typical foam compression percentages, as a function of depth, are shown in Table 1.

The depth of release is a function of both the oversize thickness ratio and the rubber tube tension. Our foam wedges were approximately 25 percent oversize in thickness; tension was adjusted to release at a 7 m depth.

We have had no failures of rotor releases in ten laboratory tests and 19 field launchings.

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8th OCEAN TECHNOLOGISTS' Meeting

November 27-28, 1978

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Mates are welcome!

Rod Mesecar, Editor
(503) 754-2206

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